Short and medium range orders in nearly frictionless diamond-like carbon

Scientific Achievement

We correlated the short and medium range orders in a set of diamond-like carbon films using Electron Energy Loss Spectroscopy (EELS) and Fluctuation Electron Microscopy (FEM) respectively. Previous studies have concentrated on only the short range ordering, that is, quantifying the absolute ratio of carbon sp^3 bonding to carbon sp^2 bonding. However, two diamond-like carbon films may have the same absolute ratios of sp^3 and sp^2 bonding, but very different medium range orders, giving rise to striking differences in their properties. This work demonstrates that the combination of EELS and FEM is a very powerful technique for uncovering structure-property relationships in amorphous carbon materials.

Significance

The etching of sp^2 bonded carbon by hydrogen during growth may play an important role in tailoring the properties of diamond-like carbon films. Diamond-like carbon grown by Plasma Assisted Chemical Vapour Deposition (PACVD) has been found to have desirable friction properties. The measured coefficient of friction was found to vary widely depending on the gaseous atmosphere in the growth chamber. Through the structural characterizations performed in this work, the frictionless properties were found to improve as the density of predominantly sp^3 bonded clusters in the material increased. This condition corresponded to a greater proportion of hydrogen in the plasma, allowing favourable growth conditions to be identified.

Performers

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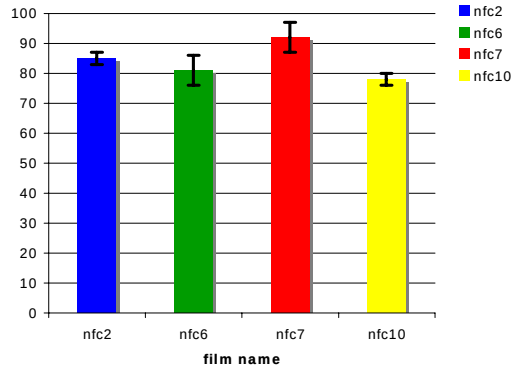
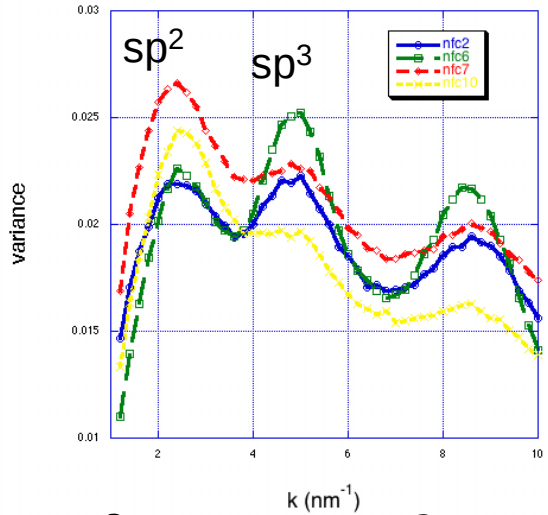
- Electron Energy Loss Spectroscopy (EELS) and Fluctuation Electron Microscopy (FEM) suggest that diamond-like carbon with a greater proportion of diamond-like clusters has the best friction properties.
- Amorphous diamond-like carbon has attractive tribological properties that need to be promoted through appropriate choice of growth conditions.
- Film *homogeneity* will be investigated in the future.



EELS → absolute sp^3:sp^2



FEM → sp^3 in clusters:sp^2 in clusters

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